

## Effect of Blended Learning Instructional Strategy on Senior Secondary School Students' Achievement in Mathematics

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### Abstract

The study examined effect of blended learning instructional strategy on secondary school students' academic achievement in mathematics. The study employed a quasi-experimental research design method. Three hypotheses guided the study. A sample size of 76 senior secondary II students drawn from two schools were assigned to experimental and control groups, using intact class. The instrument was mathematics achievement test (MAT) with reliability co-efficient value of 0.72 obtained from Kuder-Richardson formula 21. The results of the study show significant difference in the pretest and mean scores of both students in experimental and control groups with calculated F- value of 34.530 > critical F- value of 3.03,  $df = 1$  and 74 at 0.05 level of significance.. The result further revealed significant difference in the mean achievement scores in mathematics between students in experimental and control group with t- calculated 3.543,  $df = 74$  and sig. (2 tailed) = 0.26. The results also show no significant difference in the mathematics mean achievement scores between male and female students exposed to experimental condition with t- calculated .273,  $df = 32$  and sig. (2 tailed) = .547. Far reaching recommendations were provided for adoption of blended learning instructional strategy in teaching secondary school mathematics.

**Keywords:** Asynchronous Learning Environment, Blended Learning Instructional Strategy, Computer Mediated Instruction, F2F, Gender

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## Introduction

No serious nation can develop its science and technology without proper foundation in Mathematics, which is why it is widely recognized as the universal language of Science, Technology and Engineering. Everybody irrespective of vocation, profession and career is involved in daily use of Mathematics knowledge consciously or unconsciously. Adeniyi and Fatunsi (2015) stated that Mathematics is widely recognized as a core component of the curriculum and significant contributor to numerous career opportunities. In Nigeria, Mathematics is given special position in the secondary school curriculum as a core subject for Business, Humanities, Science and Technology Students. At the Junior Secondary School it is mandatory for students to pass Mathematics in the Basic Education Certificate Examinations (BECE) before they are qualified for promotion to Senior Secondary level. It is also required that a student obtains a credit pass in Mathematics to be promoted from lower to upper class in secondary school and to gain admission for science related courses in tertiary institutions.

Over the years, Nigerian students' performance in mathematics has attracted attention from researchers, parents, teachers, government, curriculum planners and school administrators. The West African Senior Secondary Certificate Examination (WASSCE) results released by West African Examination Council (WAEC) as reported by the Chief Examiners indicated that the failure rate for Mathematics in recent years is disturbing (Adigun, 2015). The performance of students in mathematics is consistently low over the years in senior secondary school certificate examination (WAEC Chief Examiners' Report, 2016). The reports attributed the dismal performance to students' effort, attitude, interest in the subject, lack of effective instructional media and teachers' methodology (Adekunle, 2017).

Against this backdrop, it is expected of mathematics teachers to shift from teacher-centered method which they are traditionally used to and embrace a learner-centered strategy that is driven by emerging instructional technologies. To buttress this perspective Harris, Mishra & Koehler (2009) submitted that for effective achievement of instructional objectives teachers should consider the use of technology pedagogy and content knowledge (TPACK). To drive classroom activities toward integration of pedagogy and technology for improved students' performance a creative and critical thinking teacher can adopt the use of blended learning instructional strategy.

Blended learning is the combination of web-based learning resources and classroom-based learning in order to

maximize the benefits of both face-to-face and online methods (Osguthorpe & Graham, 2003). Blended learning focuses on optimizing achievement of learning objectives by applying the 'right' learning technologies to transfer the 'right' skill to the 'right' person at the 'right' time (Singh & Reed, 2001). It is the combination of face-to-face and online learning environment in which information technologies are adequately deployed for effective interaction and collaboration. It's possible to have synchronous or high-fidelity interaction in a F2F environment while it's not possible in a distributed learning environment where emphasis is on self-paced learner-material interaction.

In blended learning the synchronous F2F interaction will be considered as the real time learning environment where teacher meets the students in a fixed location while on the other hand the teacher will also make use of e-learning to provide learning materials with synchronous and asynchronous technologies such as audio conference, online radio, online chat, DVD, satellite video conference e-mail, internet video conference, and broadcast television.

From the above discussions on the potentials of blended learning one may be tempted to accept the view that the combination of traditional F2F and online teaching could be more useful in solving some instructional challenges. There are pocket of studies that reported the instructional benefits of blended learning as a unique technology driven learner-centered teaching strategy. Graham (2012) conducted a study on students' achievement in social studies. The researcher employed a quasi-experimental research design with a sample of 210 students and found that students exposed to blended learning out performed those taught with conventional method. Taylor (2015) investigated the effectiveness of blended learning in teaching physics and the result revealed that students treated with blended learning significantly achieved higher than students not treated with blended learning. In another study, Slavin (2015) examined the effect of blended learning on students' attitude and achievement in English Language and found no significant difference in the attitude and achievement of students taught with blended learning strategy and those not taught with blended learning strategy. Ward (2018) in a study on effect of blended learning in secondary school geography found that there is no significant difference in the performance of geography students in experimental group and control group.

Gender remains a considerable factor in pedagogical practice due to its impacts on students' performance, attitude, interest and some other related variables. For instance,

Leach (2015) in a study examined the influence of gender on students' attitude and academic performance in English Language and found out that there was no significant difference between male and female students' attitude and academic performance in English Language. In a study by Rovai (2017), it was revealed that in secondary Biological Science, though females have a slight higher mean score than the males, but the difference in achievement was not significant. In a similar study by Dolston (2019), male students were reported to have significant achievement than females in physics. The inconclusiveness of research on the impact of gender on human endeavor makes it to be included as a moderating variable in this study.

The theoretical foundation of this study is "mixing theories of learning". Proponents of blended learning model argue that some of the best - designed learning experiences were drawn on a blend of learning theories and philosophies. In practice, value can be drawn from many instructional theories and in the case of blended learning different theories apply to different situations. One description of blended learning is that the mix consists of 'pedagogical approaches' (Driscoll, 2002), by which she meant 'behaviorism, cognitivist and constructivism'. Behaviorists' view of objective observable behavior through stimulus - response connection would be applicable in a real - time F2F learning environment, cognitivists' view will explain the roles of artificial intelligence in computer mediated instruction while constructivists offer learners multiple perspectives such as students' manipulation of computer, self-regulated learning and hands-on experiences. In the context of constructivism, the internet with its multimedia learning environment goes beyond behaviorists' or cognitivists' views and recasts learning as experiential and self - driven activities. Piaget (1972) and Vygotsky (1978) noted that students do not receive knowledge passively but actively construct it on the basis of their previous knowledge and experience. Therefore, blended learning in this study is the mixture of traditional F2F classroom environment with online environment with is the integration of pedagogical approaches.

### Statement of the Problem

There is high rate of poor performance of secondary school students in mathematics and studies show that this problem is largely due to teachers continuous use of traditional method which is now pedagogically considered outdated. Studies have also pointed out that teaching in the 21st century must be technological driven for effective students 'critical thinking, problem solving, creativity, collaboration and engagement

skills. Such technological driven strategy is the use of blended learning which has been empirically examined to be effective in some other disciplines. Therefore, this study examined effect of blended learning instructional strategy on students' achievement in mathematics.

### Purpose of the study

The purpose of the study is to examine effect of blended learning instructional strategy on senior secondary students' achievement in mathematics.

### Hypotheses

H<sub>01</sub>: There is no significant difference in the pre-test and mean scores of students in experimental and control groups

H<sub>02</sub>: There is no significant difference in the mean achievement scores in mathematics between students in experimental and control groups

H<sub>03</sub>: There is no significant difference in the mean achievement scores in mathematics between male and female students in experimental group

### Method

The study employed pretest posttest quasi experimental control design. The population consists all mathematics students in Senior Secondary II in Ogun East Senatorial District of Ogun state, Nigeria. The sample comprises of 76 SS2 Students in two selected private schools. Two local government areas were randomly selected while one school was purposively selected in each local government area. The criteria for the school selection was co-educational, availability, adequacy and students' accessibility to information communication technology (ICT) devices as well as computer laboratories. Two intact classes were used while simple random sampling technique was used to assign the schools into experimental and control groups. The instrument for data collection, mathematics achievement test (MAT) was adapted from the past question of WAEC and NECO from 1988-2017) that related to the SS 2 syllabus. The section A of MAT has students' bio-data such as age, sex and name of school, while section B is a multiple choice test containing 40-items with 4 – options. The items covered knowledge, understanding and application levels of Bloom' learning objectives.

The validity of the initial 60 items was determined by experts in mathematics education for adequacy, simplicity and relevance to the syllabus of the participants. The measure was administered to 30 students not involved in the study for the

purpose of item analysis. The difficulty and discriminating index were obtained, results of the analysis were used to pick neither too difficult nor too simple items, those that discriminate positively between strong and weak students, in all 40 items survived the item analysis. For reliability the MAT was administered on 30 SS2 students different from the main sample but with similar characteristics, this was subjected to Kuder-Richardson (KR-21) formula and a reliability co-efficient of 0.72 was obtained confirming its internal stability.

Pretest was administered to both the experimental and control groups during the first week and before the commencement of the treatment. The treatment given to the experimental group was a mix of F2F classroom instruction and learning management system (LMS) software package of selected topics in SS2 mathematics syllabus. The digitally programmed learning materials which teacher uses to manage modules has the usual features of computer mediated instruction

(CMI) such as stimulus, response, self-assessment, multimedia, self-regulated, immediate knowledge of results etc. The package was uploaded on a website and the students were given the website address to visit for interaction with the online learning materials. The students were allowed to make use of computer system in the school laboratory that are internet enabled but they were guided by the trained mathematics teacher as research assistant. Students met teacher in the face-to-face lesson and in another period they use computer system in the laboratory for online learning. The control group was taught with conventional method of chalk and talk without the use of blended learning. The treatment lasted for a period of three weeks with a well-designed instructional guide given to the two trained research assistants on the administration of the instruments, these activities were monitored by the researchers. In the fifth week for posttest, MAT was again administered but the items were rearranged. The data collected were analyzed statistically with mean and standard deviation, *t*-test and ANCOVA.

**Results**

H<sub>0</sub>: There is no significant difference in the pre-test and mean scores of students in experimental and control groups

**Table 1: Descriptive statistics of pretest posttest for experimental and control groups**

Test	Group	Mean	Std. Deviation	N
Pre-MAT	Experimental Group	2.3522	1.68242	216
	Control Group	2.2974	1.46133	230
	Total	2.7943	1.69043	446
Post-MAT	Experimental Group	13.4216	3.65290	216
	Control Group	11.5843	3.53168	230
	Total	12.6426	3.52790	446

Table 1 revealed the results of the pretest and posttest scores for the experimental and control groups. The mean pretest scores for experimental group is 2.3522 while that of control group is 2.2974. The posttest mean scores for experimental and control groups are 13.4216 and 11.5843 respectively. The posttest mean difference of the two groups is 1.8373 in favor of the experimental group.

**Table 2: ANCOVA of the experiment and control groups**

Dependent variable: Posttest scores on MAT

Source	Type III sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4384.214 <sup>a</sup>	2	2147.731	463.970	.000
Intercept	649.630	1	2064.691	530.427	.000
Pretest MAT	5332.472	1	5321.731	653.572	.000
Group	152.453	1	152.453	34.530	.000
Error	544.874	73	4.472		
Total	32786.000	76			
Corrected Total	7341.743	75			

a. R Square = .763 (Adjusted R Square = .767)

The result in table 2 shows the calculated F- value of 34.530 > critical F- value of 3.03, df = 1 and 74 at 0.05 level of significance. Thus, the difference noticed is significant to reject the hypothesis and conclude that there is significant difference in the pretest and mean scores of students assigned to experimental and control conditions

$H_{0_2}$ : There is no significant difference in the mean achievement scores in mathematics between students in experimental and control groups

**Table 3: t-test statistics of mean achievement between mathematics students in experimental and control conditions**

Test	Group	N	Mean	Std. Deviation	T	Df	Sig.(2-tailed)
Post test	Experimental	34	13.6806	4.57321	3.543	74	.026
	Control	42	12.4373	4.47432			

The table 3 above shows results of the posttest mean score between experimental and control groups. The mean posttest score for experimental group is 13.6806 while that of control group is 12.4373. The *t*-calculated is 3.543, df = 74 and sig. (2 tailed) = 0.26. Since  $P < 0.05$  there is significant difference in the posttest mean score between the two groups at 0.05 level of significance. The difference noticed is significant to reject the

hypothesis and conclude that there is significant difference in the mean achievement scores in mathematics between students in experimental and control groups.

$H_{0_3}$ : There is no significant difference in the mean achievement scores in mathematics between male and female students in experimental group

**Table 4: t-test statistics of mean achievement between male and female students in experimental and control conditions.**

Test	Group	N	Mean	Std. Deviation	T	Df	Sig.(2-tailed)
Post test	Male	19	11.6843	3.98345	.273	32	.547
	Female	15	11.7592	2.67321			

The table 4 above shows results of the posttest mean score between males and females in experimental group. The mean posttest score for males is 11.6843 while that of females is 11.7592. The *t*-calculated is .273, df = 32 and sig. (2 tailed) = .547. Since  $P > 0.05$ , there is no significant difference in the posttest mean score between male and female students at 0.05 level of significance. This implies that there is no significant difference in the mathematics mean achievement scores between male and female students exposed to experimental condition.

## Discussion of Findings

The results in hypothesis one show that the mean pretest scores for experimental group is 2.3522 while that of control group is 2.2974. The posttest mean scores for experimental and control groups are 13.4216 and 11.5843 respectively. The posttest mean difference of the two groups is 1.8373 in favor of the experimental group. These results show significant difference in the pretest and mean scores of both students in experimental

and control group, thus the hypothesis is rejected. Also, the results in table 2 show that there is significant difference in the pretest and mean scores of students assigned to experimental and control conditions with the calculated F- value of 34.530 > critical F- value of 3.03, df = 1 and 74 at 0.05 level of significance.

The results in hypothesis two show that the mean posttest score for experimental group is 13.6806 while that of control group is 12.4373. The *t*-calculated is 3.543, df = 74 and sig. (2 tailed) = 0.26. Therefore, one can observe significant difference in the mean achievement scores in mathematics between students in experimental and control group. This result is in line with the findings of Graham (2012) and Tailor (2015) who found that students exposed to blended learning significantly performed better than those taught with conventional method. This shows that the use of blended learning instructional strategy in teaching of mathematics have the potential to reduce students failure in Nigeria schools.

The results in hypothesis three show that the mean posttest score for males is 11.6843 while that of females is 11.7592. The  $t$ -calculated is .273,  $df = 32$  and sig. (2 tailed) = .547. Therefore, since  $P$  is greater than 0.05 it shows that there is no significant difference in the posttest mean score in mathematics between male and female students in experimental group. This result is in agreement with the findings of Leach (2015) and Rovai (2017) who respectively found no significant difference in achievement and attitude towards English Language and secondary Biological science between male and female students. The reason why there was no observable significant difference might be as a result of drastic change in gender stereotyped belief to gender equality which is the sustainable development goal five (SDG5).

## Conclusion

This study revealed the pedagogy efficacy of blended learning instructional strategy in the teaching - learning of secondary mathematics over conventional method because students were adequately engaged in the combination of self – regulated and F2F learning environment thereby providing motivation, information sharing and adequate feedback from the teacher and other students. The study also shows that students' gender has no significant effect on the use of blended strategy in studying mathematics because the performance of male students was not significantly higher than their female counterparts.

## Recommendations

Based on the findings of this study the following recommendations are provided:

- (1) Blended learning instructional strategy should be applied in the teaching of mathematics in Nigeria public schools as a result of its inherent potentials on improved performance.
- (2) Emerging learning technologies should be provided by relevant education stakeholders in Nigeria to public schools so that the use of blended learning for effective mathematics instruction could be possible.
- (3) Information technology experts should be trained and deployed to schools to assist teachers who want to make use of this technology driven strategy.

(4) Designers of blending learning instructional strategy should understand how to combine F2F and computer-mediated environments and take advantages of each environment.

(5) Blended learning is highly recommended for students because it has the advantage to improve the IT knowledge and skills of students over time.

(6) For the promotion of social interaction between teacher-student and student-student the use of blended learning is recommended for the teaching of mathematics in Nigerian schools.

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